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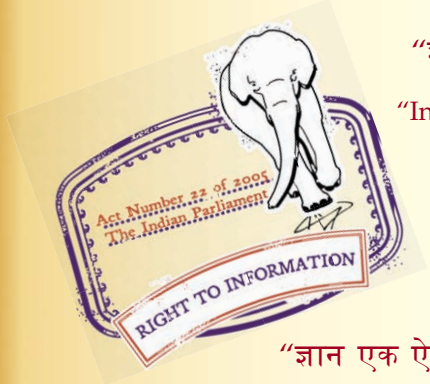
IS 11346 (2002): Tests for Agricultural and Water Supply Pumps - Code of Acceptance [MED 20: Pumps]



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"Knowledge is such a treasure which cannot be stolen"

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भारतीय मानक

कृषि व जलपूर्ति के पम्पों के लिये स्वीकार्यता परीक्षण की संहिता

(पहला पुनरीक्षण)

Indian Standard

TESTS FOR AGRICULTURAL AND WATER SUPPLY PUMPS — CODE OF ACCEPTANCE

(First Revision)

ICS 23.100.10

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

December 2002

Price Group 9

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Pumps Sectional Committee had been approved by the Mechanical Engineering Division Council.

This standard was first published in 1985 primarily for testing set up and procedures for agricultural pumps, both for coupled and monoset types with a view to make a standardized test set up and procedure available for various testing laboratories so that results obtained are identical, of course, within certain limits.

Since then 4 amendments were issued. With the revision of various pump specifications and publication of new standards on various types of pumps like centrifugal jet, engine monoset and openwell submersible pumps, need was felt to revise the standard with a view to make a comprehensive testing code which may include all types of agricultural and water supply pumps.

Procedures for acceptance testing of pumps as per IS 9137 : 1978 'Code for acceptance tests for centrifugal, mixed flow and axial pumps — Class C' may also be followed at the option of the pump manufacturers.

It is suggested that testing shall be stopped as soon as the frequency of input supply falls beyond permissible limits. Evolving a correction factor may be a difficult proposition. It is also suggested that the testing shall be done at rated voltage. The input voltage may be maintained at rated voltage with the help of variable voltage transformer.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

TESTS FOR AGRICULTURAL AND WATER SUPPLY PUMPS — CODE OF ACCEPTANCE

(First Revision)

1 SCOPE

This standard lays down broad basis for testing set up and testing procedures for agricultural and water supply pumps conforming to the following Indian Standards:

IS No.	*Title*
6595 (Part 1) : 2002	Horizontal centrifugal pumps for clear, cold water — Specification: Part 1 Agricultural and rural water supply purposes (*third revision*)
8034 : 2002	Submersible pumpsets — Specification (*second revision*)
8418 : 1999	Pumps — Centrifugal self-priming — Specification (*first revision*)
8472 : 1998	Centrifugal regenerative pump for clear, cold water — Specification (*first revision*)
9079 : 2002	Electric monoset pumps for clear, cold water for agricultural and water supply purposes — Specification (*second revision*)
11501 : 1986	Engine monoset pumps for clear, cold water for agricultural purposes — Specification (*first revision*)
12225 : 1997	Centrifugal jet pump — Specification (*first revision*)
14220 : 1994	Open well submersible pumpsets — Specification

2 REFERENCES

The standards listed at Annex A contain provisions which, through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards.

3 MEASUREMENTS

3.1 Methods of Measurements

3.1.1 *Measurement of Rate of Flow*

a) Volumetric tank method (*see* **3.2.1.1**),
b) Vee-notch method (*see* **3.2.1.2**),
c) Orifice plate method (*see* **3.2.1.3**),
d) Flow meters (*see* **3.2.1.4**), and
e) Any other method permitted in IS 9137 or a method using a higher accuracy equipment.

3.1.2 *Head Measurement*

a) Delivery head measurement by mercury manometer or pressure gauge,
b) Suction head measurement by vacuum gauge or mercury manometer, and
c) Head measurement by pressure transducers.

3.1.3 *Power Measurement*

a) One three-phase wattmeter or two single-phase wattmeters for three-phase motors, and
b) One wattmeter for single-phase motors.

3.1.4 *Speed Measurement* (*see* **3.2.4**)

3.2 Details of Apparatus

3.2.1 *Measurement of Rate of Flow*

Depending upon flow rate, following methods may be adopted. Volumetric tank method shall be used for flow rate up to 20 l/s.

3.2.1.1 *Volumetric tank method*

This method shall be used for flow rate up to 20 l/s. While using this method following points shall be considered:

a) For each observations, rise of water level in collecting tank shall not be less than 300 mm.
b) Collection of water shall not be for less than 30 s. This duration shall be extended if required to observe (a).
c) The time shall be taken with an accurate stopwatch having least count of 0.5 s or less.
d) There shall be an arrangement for quickly switching the full flow into and away from the measuring tank. Alternatively, if such switching arrangement is not there and flow is continuously taken in volumetric tank, height of same shall not be less than 1.2 m.
e) While collecting the discharge in volumetric tank, manometric suction lift shall not vary by more than 0.05 m.
f) Volumetric tank shall be accurately calibrated by volumetric method.

g) During collection of water in volumetric tank, water level in sump shall be maintained by make up water. Alternatively, sump area shall be large enough so as to limit the variation of water level within 0.05 m. Table 1 gives the minimum area of sump required for various discharge rates so as to limit variation of water level within 0.05 m. Table 1 also covers maximum area of volumetric tank so as to ensure rise of water level in collecting tank as minimum 300 mm.

Table 1 Minimum Sump Area

[*Clause* 3.2.1.1 (g)]

Sl No.	Maximum Discharge Rate	Minimum Sump Area	Maximum Area of Volumetric Tank
	l/s	m^2	m^2
(1)	(2)	(3)	(4)
i)	1.5	0.9	0.15
ii)	5.0	3.0	0.5
iii)	10.0	6.0	1.0
iv)	15.0	9.0	1.5
v)	20.0	12.0	2.0

3.2.1.2 *Vee-notch method*

The Vee-notch provides a convenient method of measurement of discharge from 120 to 7 200 l/min. For small discharges, that is, from 120 to 2 400 l/min, a half 90° Vee-notch is preferred. The half 90° Vee-notch has half the area of a 90° Vee-notch, the distance across the top being equal to the vertical depth and the sides being symmetrical about the vertical axis. The discharge of water over a half 90° Vee-notch is half that over a 90° Vee-notch with the same head.

Figure 1 gives dimensions for a 90° Vee-notch capable of measuring rate of flow from 2 to 35 l/s and up to 60 l/s. Figure 1 also gives dimensions of the notch section, surface to be machined accurately, location of the notch with respect to vertical planes (*see also* IS 9108).

a) *Formulae for volume rate of flow* — The volume rate of flow shall be computed from the following equations:

   i) If the Vee-notch is cut in a polished brass plate:

      Volume rate of flow in l/s = $H^{2.48}/20\,600$

      where H = head over the notch in millimetre.

   ii) If the Vee-notch is cut in a sheet of commercial steel plate:

      Volume rate of flow in l/s = $H^{2.47}/19\,150$

b) *Precautions* — For accurate results, the following precautions shall be taken:

   i) The thickness of the lip of the notch shall be 1.5 mm with a bevel of 45° leading downstream and with the upstream edge perfectly sharp. The face of the notch shall be smooth and set vertically at right angles to the channel of approach and the sides of the notch shall be equally inclined to the vertical. A carefully finished notch made from polished brass plate or from a commercial steel plate is recommended, but the former is to be preferred. Rusting and pitting of the notch face may increase the discharge by as much as two percent above that computed from the above formula. The tolerances for the dimensions affecting the flow rates such as Vee-notch lip thickness, bevel angle, etc, shall be as per IS 2102 (Parts 1 and 2), medium grade.

   ii) The head shall be measured at the sides of the flume at a distance upstream from the notch, minimum four times the maximum head to be measured. The gauge shall preferably be placed in a separate chamber connected to the flume by a pipe normal to the flume.

   iii) The depth from the apex of the notch to the bottom of the channel shall not be less than 150 mm on the downstream side, while on the upstream side, it shall not be less than 300 mm for heads up to 230 mm or less than 450 mm for higher heads.

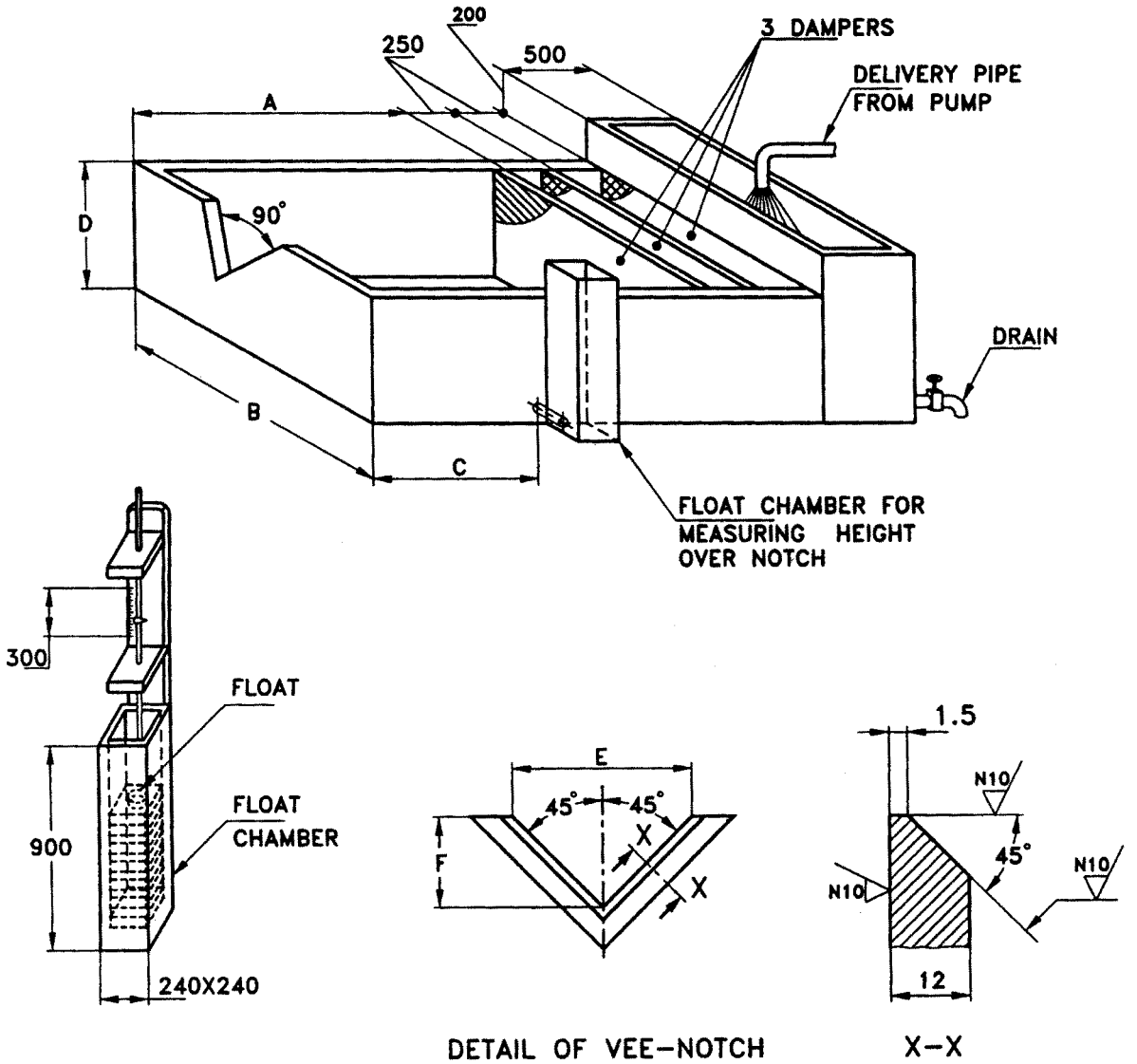
   iv) The width of the channel of approach shall not be less than 1.2 m for heads up to 230 mm and less than 1.8 m for heads up to 450 mm.

   v) There shall be no projecting surfaces whatever either on the notch face or on the channel side, since these interfere with the smooth flow of water to the notch.

   vi) Swirling of water in the approach channel shall be prevented by suitably placing baffles upstream to the point at which the head is measured.

   vii) The water level downstream may be allowed to rise within 25 mm of the apex of the notch without affecting the result, but shall not be allowed to rise above this level when measurements are being taken.

   viii) Gauge zero shall be determined as per **10.3.3** of IS 9108.



Dimensions	*For Flow Rates* 2 l/s to 60 l/s	*For Flow Rates* 2 l/s to 35 l/s
A	2 700, *Min*	2 200, *Min*
B	1 800, *Min*	1 200, *Min*
C	1 150, *Min*	1 000, *Min*
D	810, *Min*	600, *Min*
E	720, *Min*	600, *Min*
F	360, *Min*	300, *Min*
Two floating wooden planks/ screen/perforated plates	1 600 × 200	1 000 × 200

All dimensions in millimetres.

FIG. 1 MEASUREMENT OF RATE OF FLOW

c) *Limits of accuracy* — If every care is taken with the setting and reading of gauges, with the construction of notch and the channel of approach, this method shall give the rate of flow within ±1.5 percent accuracy.

3.2.1.3 *Orifice plate method*

The flow rate may be measured by orifice plates as indicated in IS 2952 (Part 1).

3.2.1.4 *Flow meters*

The flow rate may be measured by using the following flow meters:

a) Turbine type flow meter,
b) Vortex type flow meter,
c) Rotary piston type flow meter, and
d) Magnetic flow meter.

3.2.2 *Head Measurement*

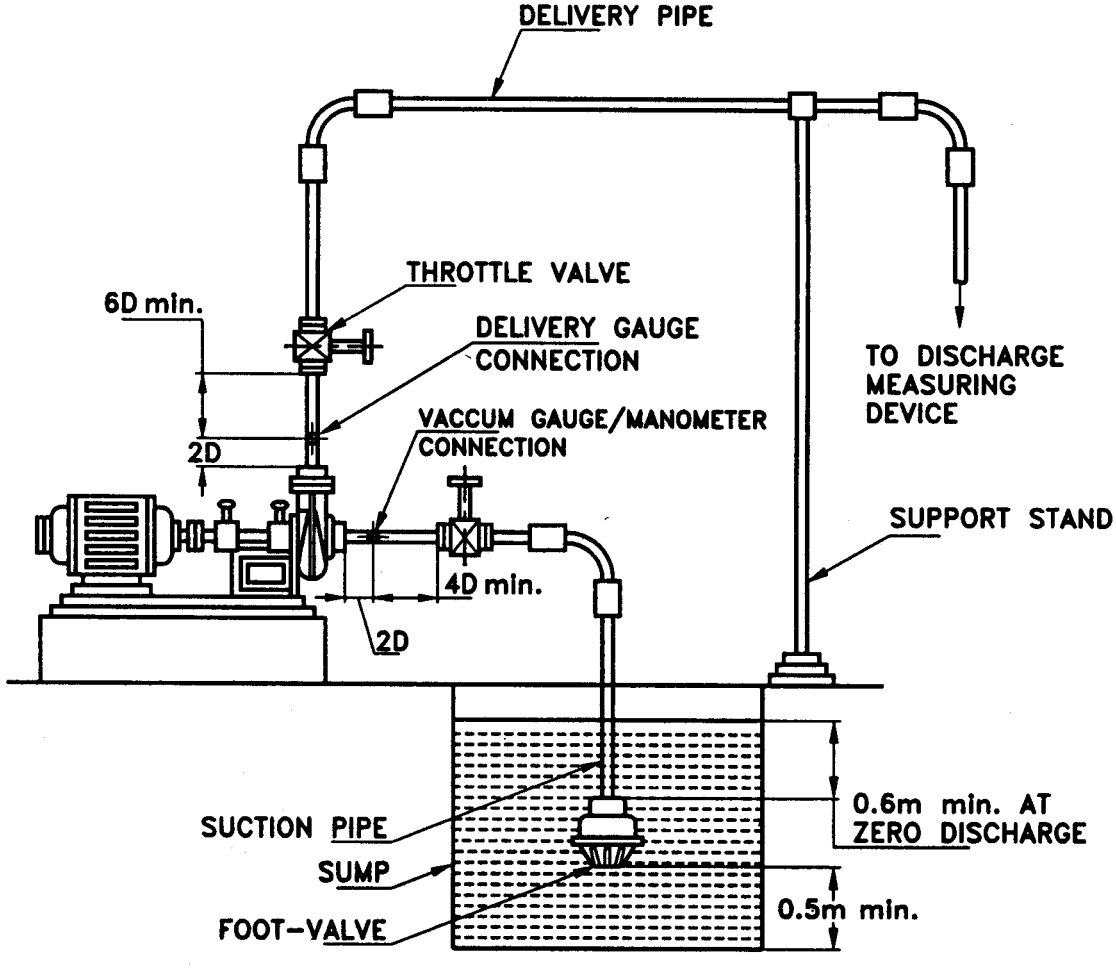
a) *Delivery head* — A mercury manometer or pressure gauge shall be used for this purpose.
b) *Suction head* — For this purpose a vacuum gauge or a mercury manometer shall be used.

3.2.2.1 Pressure transducers, if used, shall be of suitable range for measuring suction head and delivery head.

3.2.2.2 Instead of mounting gauges directly on the pipes, they shall be placed on separate stand.

3.2.2.3 *Precautions and connections for the gauges*

a) For suction lift value, a mercury manometer or a vacuum gauge shall be connected with tapping made in the suction line as shown in Fig. 2 and the same may be connected to the tapping point by flexible hose preferably transparent. However, the dimension *4D, Min*



Sump area = Delivery/Volumetric tank area
D = Normal pipe dia

FIG. 2 TYPICAL TEST SET UP FOR NON-SELF-PRIMING PUMPS

shall in no case exceed 1.5 m. The nominal diameter of the suction pipe shall be equal to the size of the pump suction.

b) For the value of the delivery head, a bourdon type pressure gauge or mercury manometer shall be connected to the delivery line with tapping as shown in Fig. 2. However, the dimension *4D, Min* shall in no case exceed 1.5 m. The nominal diameter of delivery pipe shall be equal to the delivery size of the pump. Here again the gauge or manometer shall be connected to the tapping point through a flexible hose preferably transparent.

c) When bourdon type gauges are used, they shall be of suitable range for the heads to be measured (the gauge range shall be about twice the maximum head to be measured). It is recommended that the drain cocks be placed immediately below the gauges and that frequently tests be made to determine whether pipe connections of the gauge are filled with water. With this form of gauge, care shall be taken to eliminate any leaks in the connecting pipes and to avoid the trapping of air in the connecting pipe or hose.

   In the case of gauges fitted for measurement of suction vacuum, it should be ensured that the connecting pipe is free of water.

d) The gauge, when calibrated and used, shall be in an upright position. On no account shall any bourdon type gauge be fixed so that any strain is placed on its case, as its readings may thereby be seriously affected.

e) The end of the connecting tube or pipe shall be flush with the inside of the conduit in which the pressure is to be measured and shall have its axis at right angles to the direction of flow.

3.2.2.4 *Limits of accuracy*

Accuracy within ±1 percent shall be expected, provided the above precautions are observed carefully.

3.2.3 *Measurement of Power Input*

A three-phase wattmeter or two single-phase wattmeters shall be used for measuring power input to the three-phase motor.

3.2.3.1 In case of direct coupled pumps, pre-calibrated motors for testing shall be used. Motor output shall be treated as pump input. For monoset pumps (*see* IS 9079), submersible pumpsets (*see* IS 8034) and openwell submersible pumpsets (*see* IS 14220) input to motor itself is taken to derive the overall efficiency.

3.2.3.2 Wattmeter used for power measurement shall be of accuracy class 1.5 or superior. For type test wattmeter shall be of accuracy class 0.5.

3.2.3.3 *Fuel consumption*

One pipette and stop watch should be used to measure fuel consumption when pump is coupled with diesel engine.

3.2.4 *Speed Measurement*

3.2.4.1 The speed shall be measured by a mechanical or optical tachometer.

3.2.4.2 The accuracy of the tachometer shall be 1.4 percent or superior.

3.2.4.3 In the case of immersed pumps, speed may be measured by slip-coil method/magnetic pick up method. In case of slip-coil method, total number of turns in coil shall be sufficient enough to get adequately powerful signals. It shall be connected through a galvanometer/slip meter. For a specific duration of time, slip is to be counted and corrected for the supply frequency or the slip-coil may be directly connected to the display meter for reading the slip and/or rpm.

3.3 Calibration of Apparatus

All instruments to be calibrated periodically at a frequency to be decided by the instrument user.

NOTE — Calibration of volumetric tank, Vee-notch, orifice plate and ventury meter shall be by geometrical measurements and deemed to have been met, if they meet the specified requirements as given in relevant standards. For geometrical measurements of Vee-notch IS 9108 shall be referred.

4 TEST SET UP

An illustrative test set up is shown in Fig. 2. As far as possible, the test set up shall conform to the model test set up. However, the water level in the pump and the location of throttle valve and gauge connection shall conform to Fig. 2.

4.1 Precautions

a) In case of direct coupled pumpset, proper alignment shall be ensured.

b) Air tightness in suction line shall be ensured.

c) The offset pipe of suction line shall either be horizontal or inclined upward towards the pump and shall never be inclined downward towards the pump to avoid air trapping.

d) When manometer is used to measure vacuum at suction, it shall be connected to the suction pipe through a transparent tube. During each observation it shall be ensured that there is no water column in the tube.

4.2 Priming Arrangement

A non-return valve or a vacuum pump shall be used for this purpose.

5 TEST PROCEDURE

5.1 Test Procedure for Horizontal Centrifugal Pumps and Monosets [*see* IS 6595 (Part 1) and IS 9079]

5.1.1 Test procedure for verification of guarantee with respect to rate of flow, total head, pump efficiency or overall efficiency and power input is specified in **5.1.2**.

5.1.2 A minimum of six sets of readings inclusive of zero flow and maximum flow conditions preferably at equal intervals of rate of flow or delivery head shall be taken. When guaranteed duty head is 10 m or above, the value of manometric suction lift shall be as per Table 2. When guaranteed duty head is below 10 m the value of manometric suction lift shall be duty point head (H-4 m) or the value as per Table 2 whichever is less.

5.1.3 *Precaution*

Air tightness of suction line must be ensured before carrying out the performance test. To ensure this check, the delivery gauge reading remains constant at least for 1 min when the delivery throttle valve is fully closed.

5.1.4 While carrying out test for manometric suction lift as per **5.1.2**, correction shall be applied to manometric suction lift figures as specified in Table 2 for altitude at the test place and water temperature other than 33°C. These corrections shall be in accordance with **5.1.5** and **5.1.6**.

5.1.5 *Correction for Altitude*

Barometric pressure shall be recorded at test place. The difference between atmospheric pressure at the test place and 10.33 mWC (that is atmospheric pressure at MSL) shall be deducted from manometric suction lift figures given in Table 2 [*see* Annex B, example (a)].

5.1.6 *Correction for Temperature*

Manometric suction lift specified in Table 2 shall be increased or reduced as given below when water temperature is below or above 33°C [*see* Annex B, example (a)].

Water Temperature	*Vapour Pressure*	*Correction in Manometric Suction Lift Above and Below 33°C Water Temperature*
°C	mWC	mWC
10	0.13	+0.39
15	0.18	+0.34
20	0.24	+0.28
25	0.33	+0.19
30	0.43	+0.09
33	0.52	+0.00
35	0.58	–0.06
40	0.76	–0.24
45	1.00	–0.48
50	1.28	–0.76

5.1.7 *Fluctuations*

The maximum permissible amplitude of oscillation as percentage of mean value of quantity being measured are given below:

Table 2 Manometric Suction Lift at Mean Sea Level and 33°C Water Temperature for Various Speeds and Discharge Rates

(*Clauses* 5.1.2, 5.1.4, 5.1.5 *and* 5.1.6)

Sl No.	Manometric Suction Lift mWC	Speed Range (rpm)					
		1 200-1 600	1 601-2 000	2 001-2 500	2 501-2 900	2 901-3 300	3 301-3 600
		Discharge Rate(l/s)					
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	6.0	Up to 72	Up to 46	Up to 30	Up to 24	Up to 17	Up to 14
ii)	5.5	72-93	46-57	30-37	24-29	17-21	14-18
iii)	5.0	—	57-67	37-43	29-33.5	21-25	18-21
iv)	4.5	—	67-78	43-50	33.5-38.5	25-29	21-24
v)	4.0	—	78-89	50-57	38.5-43.5	29-33	24-28
vi)	3.5	—	—	57-64	43.5-50	33-37	28-31

Measured Quantity	*Maximum Permissible Amplitude of Oscillations*
Rate of flow	± 6%
Suction lift/delivery head	± 6%
Power	± 6%
Speed of rotation	± 2%

NOTES

1 Where a 6 percent change in flow shall result in a calculated 12 percent change in head, the maximum permissible amplitude of the observed differential head shall be ± 12 percent.

2 In the case of inlet total pressure head and outlet total pressure head measurement, the permissible oscillation shall be calculated on the pump total head.

The value of manometric suction lift shall be corrected for altitude at test place and water temperature as per **5.1.5** and **5.1.6** respectively (*see* examples given in Annex B).

NOTE — While the manometric suction lift indicated above is to be maintained at specified duty point, it may not be always practicable to achieve this situation during testing. In such cases the requirements of this clause shall be deemed to have met, if the manometric suction lift is maintained within –5 percent to +10 percent of specified discharge rate.

5.2 TEST PROCEDURE FOR SUBMERSIBLE PUMPSETS (IS 8034) AND OPENWELL SUBMERSIBLE PUMPSETS (IS 14220)

5.2.1 Test procedure for verification of guarantee with respect to rate of flow, total head and overall efficiency is specified at **5.2.2**.

5.2.2 A minimum of six sets of readings shall be taken inclusive of zero flow and maximum flow conditions, preferably at equal intervals of rate of flow or delivery head. These test results are referred for verifying guarantee as per **8.1** (a), (b) and (c) with respect to the operational duty point.

5.3 TEST PROCEDURE FOR DIESEL ENGINE DRIVEN PUMPSETS (IS 11501)

In the case of pumps coupled with diesel engines, there is no need for computing power, pump efficiency or overall efficiency. Only fuel consumption shall be measured as per IS 11501.

6 OBSERVATIONS

The following observations shall be recorded in a test record sheet. Specimen sheets for IS 6595 (Part 1), IS 8034 and IS 9079 are given at Annex C, Annex D and Annex E respectively.

These observations shall be used to derive pump characteristics:

a) Vee-notch, flowmeter, venturimeter or volumetric tank reading;

b) Delivery gauge and suction gauge readings or manometric readings, if applicable;

c) Tachometer reading/speed measurement;

d) Gauge distance correction factor, Z;

e) Voltmeter reading;

f) Wattmeter reading;

g) Ampere meter reading; and

h) Frequency reading.

NOTE — The above reading shall be used to calculate (derive) the pump/pumpset characteristics curve which shall be shown graphically.

7 COMPUTATION OF TEST READINGS

7.1 Computation of Total Head for Pumps and Monosets as per IS 6595 (Part 1) and IS 9079

Total head at observed speed:

$$H = H_{man} + pd + z + \frac{(V_d^2 - V_s^2)}{2g}$$

where

H_{man} = Vacuum gauge/suction/manometer reading in meters of water column;

pd = Delivery gauge reading in meters of water column;

Z = Gauge distance correction factor for delivery gauge centre and inlet pipe centre in meters. If the delivery gauge centre is below the inlet pipe centre, Z is subtracted from the delivery gauge reading and if the delivery gauge centre is above inlet pipe centre, Z is added to the delivery gauge reading;

The gauge distance correction factor shall never be applied to the suction vacuum gauge or mercury manometer reading irrespective of their positions;

V_d = Velocity at delivery gauge connection, m/s;

V_s = Velocity at suction gauge connection, m/s; and

g = Acceleration due to gravity in m/s^2.

7.2 Head Measurement for Submersible Pumpsets (IS 8034) and Openwell Submersible Pumpsets (IS 14220)

7.2.1 *Measurement of Total Head* (*see* Fig. 3).

The total head is made up of:

a) Distance between pumping water level to gauge centre distance in m (Z);

b) Delivery gauge reading in m in water column (h); and

c) Velocity head in m ($V_d^2/2g$)

Total head at observed speed, $H = Z + h + V_d^2/2g$.

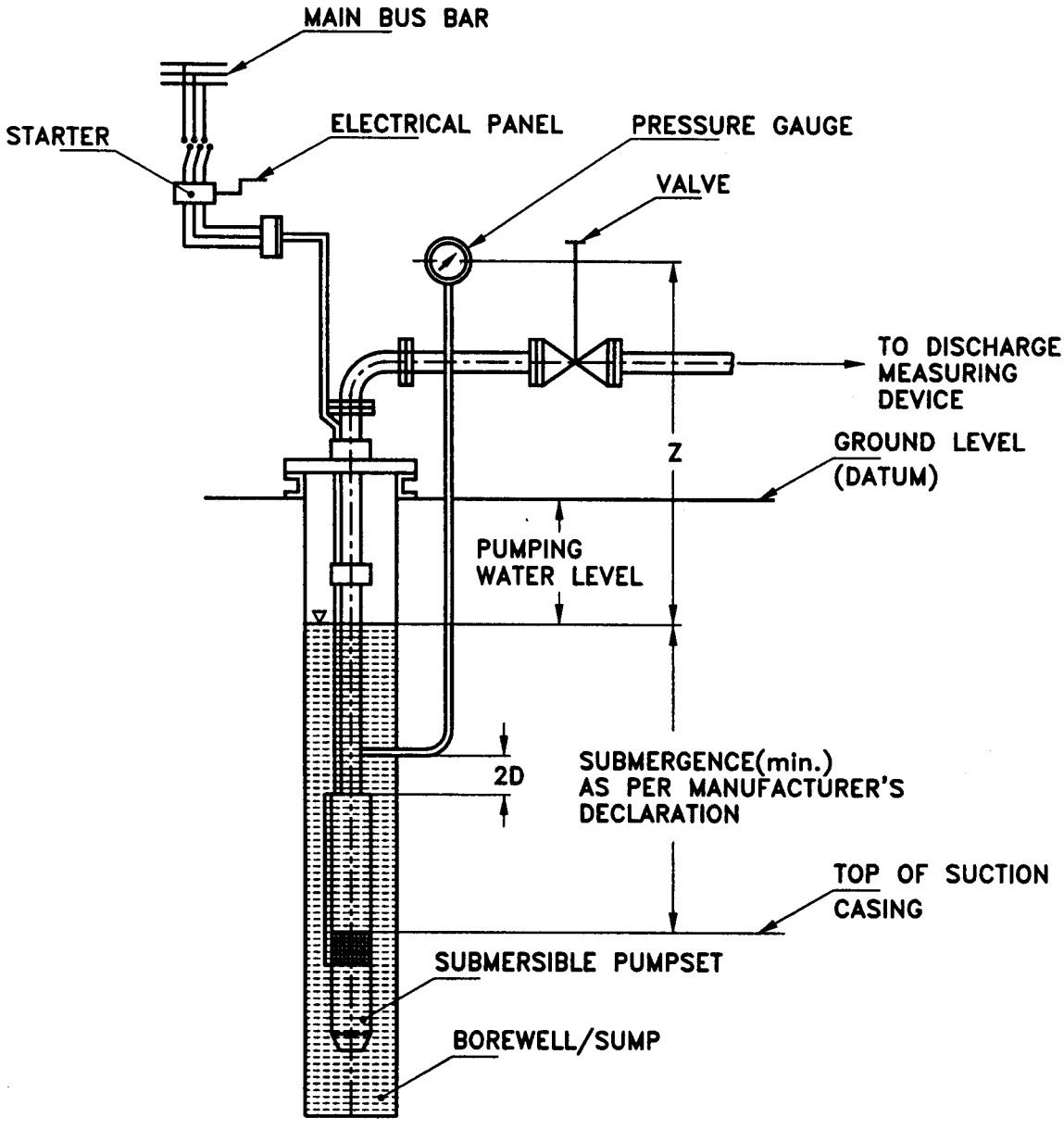


FIG. 3 TYPICAL TESTING ARRANGEMENT FOR SUBMERSIBLE PUMPSETS

7.3 Computation of Power

Pump input shall be derived from input/output curve of the motor in case of direct coupled pumpsets.

7.4 Efficiency

7.4.1 *Efficiency for Pumps as Per* IS 6595 (Part 1)

$$\text{Pump efficiency, } \eta_p = \frac{H \times Q}{102 \times \text{Input to pump}}$$

where

H = head in metres of water column;

Q = discharge in l/s; and

Input to pump in kW.

7.4.2 *Overall Efficiency for Pumps/Pumpsets as per* IS 8034, IS 8418, IS 8472, IS 12225 and IS 14220

$$\text{Overall efficiency, } \eta_{ov} = \frac{H \times Q}{102 \times \text{Input to motor}}$$

where

H = head in metres of water column;

Q = discharge in l/s; and

Input to motor in kW.

7.5 Conversion of Performance

7.5.1 *For Coupled Pumps as per* IS 6595 (Part 1)

Following affinity laws shall be applied to convert the performance at rated speed:

a) $Q \propto n$
b) $H \propto n^2$
c) $P \propto n^3$

7.5.2 *For Pumps/Pumpsets as per* IS 8034, IS 8418, IS 8472, IS 9079, IS 12225 and IS 14220

Following affinity laws shall be applied to convert the performance at rated frequency:

a) $Q \propto f$
b) $H \propto f^2$
c) $P \propto f^3$

8 VERIFICATION OF GUARANTEE

8.1 The pumpset shall be guaranteed at specified duty point for the following:

a) Rate of flow;
b) Total head;
c) Pump efficiency in case of electric motor coupled sets and overall efficiency for electric monoset/submersible pumpsets;
d) Manometric suction lift (not for submersible pumpsets);
e) Fuel consumption when diesel engine is coupled with pump; and
f) Current/power input as the case may be.

8.2 Tested *H-Q* points observed as per **5.1.1** shall be converted to the rated speed/rated frequency. These points shall be plotted on a graph and a continuous curve shall be drawn. Plot guaranteed duty point Q_G H_G on this graph (*see* Fig. 4). If the guaranteed duty point lies below the tested graph, pump shall be deemed to have conformed to the head and discharge requirements provided the prime mover is not over loaded in the declared operating head range.

If the guaranteed points lie above the tested graph then vertical distance (H) and horizontal distance (Q) are found from the graph and the following shall be evaluated:

$$\left(\frac{H_G \times X_H}{H}\right)^2 + \left(\frac{Q_G \times X_Q}{Q}\right)^2 \geq 1$$

where X_Q and X_H are agreed tolerances applicable to Q and H respectively

$X_Q = 0.07$
$X_H = 0.04$

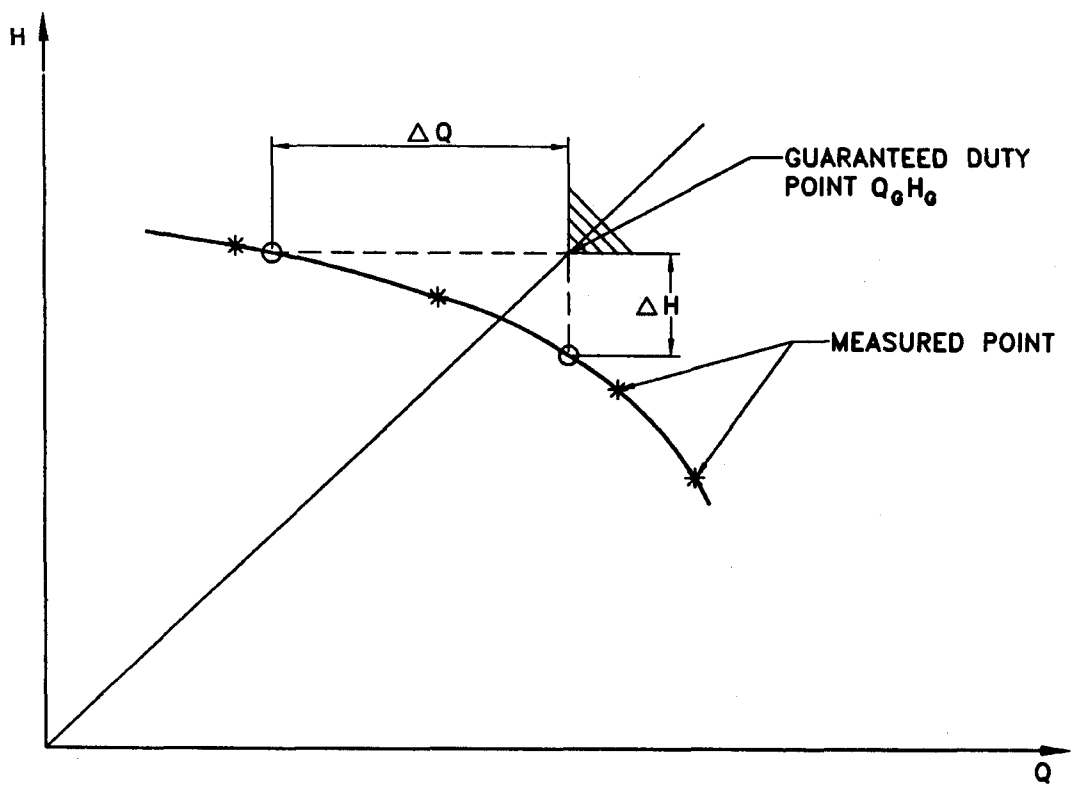


FIG. 4 CURVES *QH* FOR VERIFICATION OF GURANTEE

Thus if the total amount is greater or equal to 1.0, the guarantee condition shall be deemed to have been met and if total amount is less than 1.0, the guarantee condition has not been achieved.

8.3 The efficiency shall be derived from the *Q-H* curve where it is intersecting the straight line passing through Q_G, H_G and the zero of *Q-H* curve. The value obtained shall not be less than the following:

a) For direct coupled pumps as per IS 1595 (Part 1):

Pump efficiency, $\eta_p = 0.950 \times \eta_{pg}$

b) For monoset / submersible / openwell submersible pumpset as per IS 9079, IS 8034 and IS 14220:

Overall efficiency, $\eta_{ov} = 0.955 \times \eta_{ovg}$

However the efficiency shall not be less than the minimum efficiency specified in the relevant Indian Standard and in case of engine coupled pumpset, fuel consumption shall be verified in accordance with IS 11501.

8.4 Manometric suction lift shall be in accordance with **5.1.1**.

8.5 Primemover shall not get overloaded in the recommended operating head range in case of coupled set as well as monoset/submersible pumpset. For this purpose the manufacturer shall declare the recommended primemover rating in case of coupled set.

8.6 Guarantee and Tolerances on Pump Performance

When pump is coupled with diesel engine, it shall be in accordance with **15** of IS 11501.

9 TEST PROCEDURE FOR REGENERATIVE PUMPS FOR CLEAR, COLD WATER (IS 8472)

9.1 Hydrostatic Test

Pump casing shall be of robust construction and shall be tested to withstand the shut-off pressure for at least 15 s.

9.2 The pump shall be capable to perform as per guaranteed duty point at the manometric suction lift of 4 m.

9.3 Self-Priming Test (for Self-Priming and Semi Self-Priming Pumps only)

The pump shall be tested for self-priming time at a static suction lift of minimum 1.5 m for semi self-priming (*see* Fig. 5) and minimum static suction lift of 3 m for self-priming pump (*see* Fig. 6).

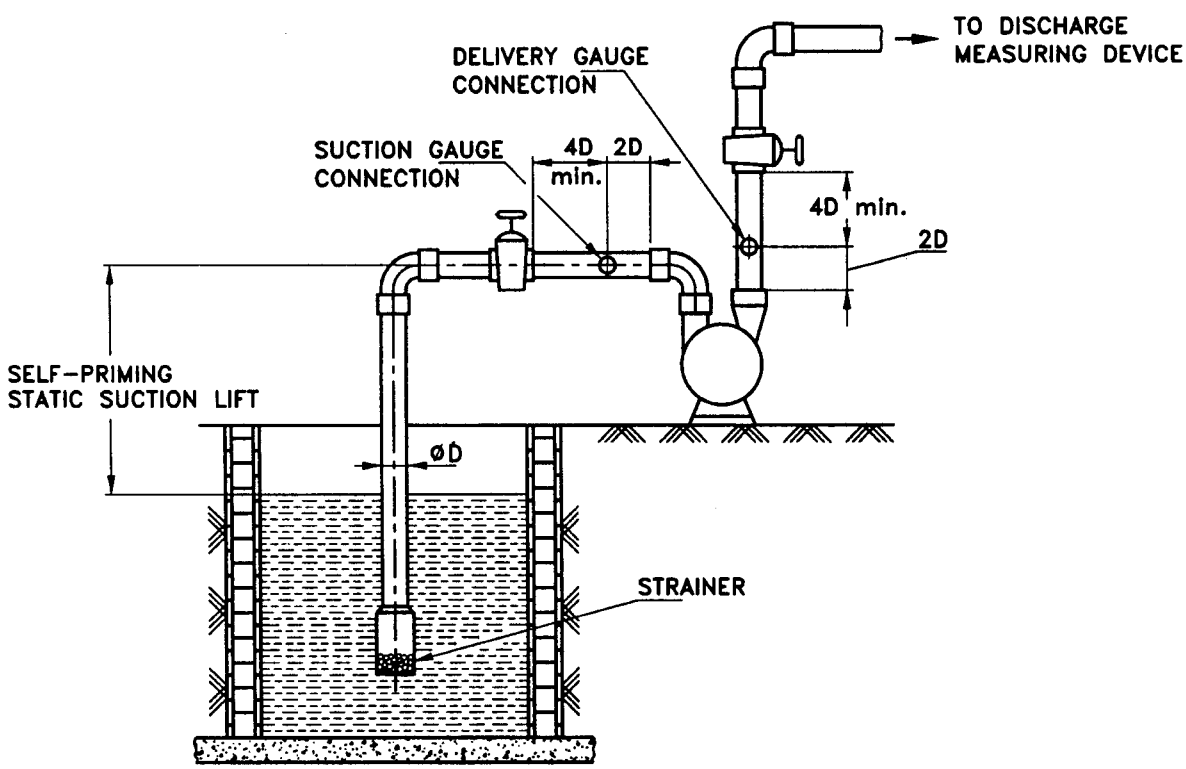


FIG. 5 SEMI SELF-PRIMING TEST SET-UP

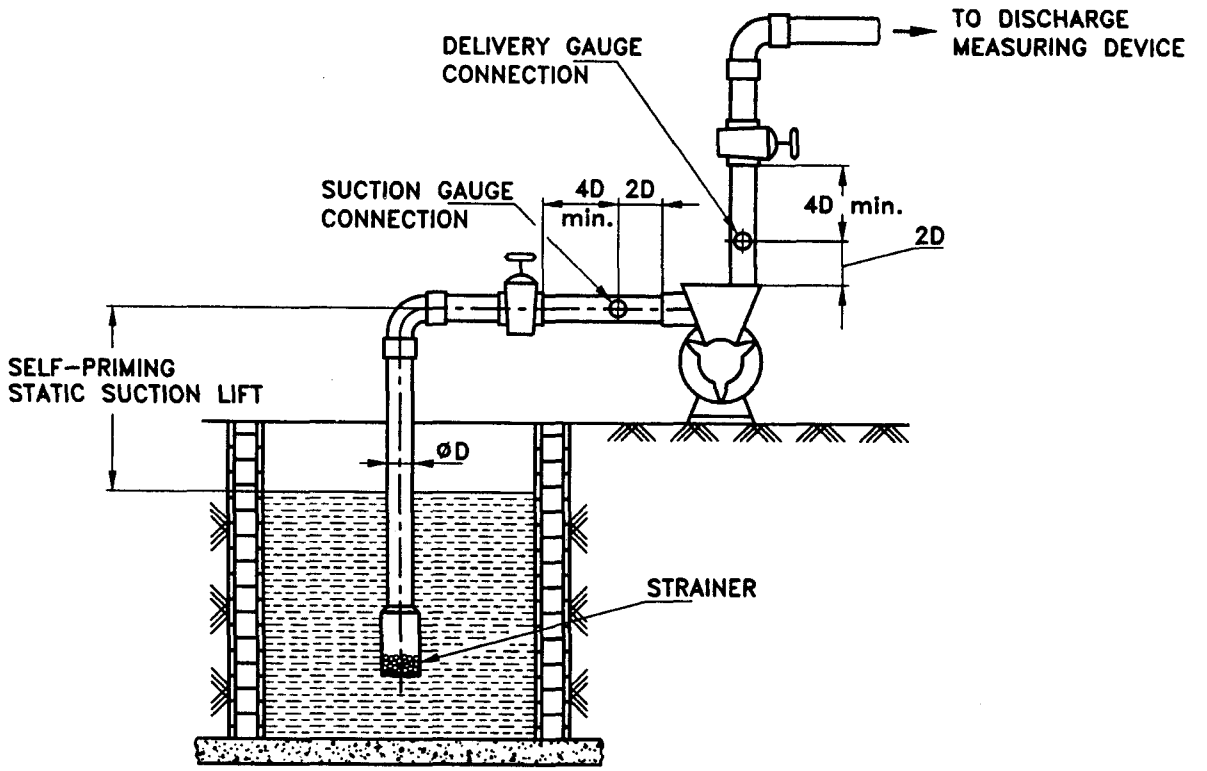


FIG. 6 SELF-PRIMING MONOSET TEST SET-UP

The nominal sizes and suction and delivery of the pump shall be as covered in IS 1239 (Part 1), IS 12231 and IS 4984.

NOTE — In case a different bore size of suction pipe other than declared bore size is used for this test, the priming time will be directly proportional to the area ratio (*see* Table 3 of IS 8418).

9.4 The observations of tests shall be recorded in a test record sheet. A specimen sheet is given in Annex B of IS 8472.

9.5 Bare pumps shall be tested using calibrated prime movers.

9.6 Guarantee of Performance

9.6.1 When tested in accordance with **9.1** to **9.5** the pumps shall be guaranteed for their performance of:

a) Discharge, total head, input power at the guaranteed duty point and the value of full load current (maximum) at the operating head range as specified in IS 996 or IS 7538 and where the limits are not specified the same shall be declared by the manufacturer.

b) Maximum self-priming static suction lift at mean sea level.

c) Maximum self-priming time at minimum 1.5 m static suction lift for self-priming pumps.

NOTE — The pump performance shall be declared at the rated speed of the prime mover. In case of bare pumps, the rated speed shall be declared by the manufacturer.

9.6.2 While carrying out verification of performance as per **9.2**, **9.6.1** (b) and **9.6.1** (c), corrections shall be applied for altitude at the test place and water temperature other than 33°C, the corrections to be applied.

9.7 Verification of Guarantee — Tolerances

9.7.1 At rated speed, the pump shall give a minimum of 90 percent of rated total head at a minimum of 90 percent of rated discharge. The pump shall not take more than 110 percent of the declared power input at the guaranteed duty point.

9.7.2 The motor shall not get overloaded in the operating head range of ± 25 percent of rated head at rated voltage when the supply frequency is within the limits ± 3 percent of the rated frequency. The maximum allowable current shall be 1.07 times of the full load current, *Max* as specified in IS 996 or IS 7538 and where the limits are not specified the same shall be declared by the manufacturer.

9.8 Curves of Discharge (*Q*) *versus* Total Head (*H*), Input Power (*IP*) and Current (*I*) shall be plotted.

a) Test readings of *Q*, *H* and *IP* corrected for rated speed shall be plotted on a graph and

continuous curves drawn. Plot guaranteed duty point Q_G H_G on this graph (*see* Fig. 7). If the guaranteed duty point lies below the *Q-H* curve, pumps shall be deemed to have conformed to the head and discharge requirements.

For verification of input power, draw a straight line through the origin and Q_G H_G to intersect the *Q-H* curve. Draw a vertical line through the point of intersection so that it intersects the *Q-IP* curve. The value of *IP* at the point of intersection shall be within the limit specified in **9.7.1**.

b) Test readings of *Q*, *H* and *I* shall be plotted on a graph and continuous curves drawn. Horizontal lines shall be drawn at duty point head +25 percent and duty point head −25 percent to intersect the *Q-H* curve (*see* Fig . 8). Vertical lines shall be drawn through the points of intersection to intersect the *Q-I* curve. If the maximum value between the points of intersection on the *Q-I* curve is not more than the value specified in **9.7.2**, the primemover is not overloaded.

c) If the guaranteed duty point lies above the test *Q-H* curve then a point 0.9 Q_G, 0.9 H_G shall be plotted. If this point lies on or below the curve (*see* Fig. 9), the guarantee condition in respect of head and discharge shall be deemed to have been met, not otherwise.

d) For conformity regarding input power and current for monoset pumps [*see* **9.8** (a) and (b)]. In the case of bare pumps, a calibrated prime mover shall be used.

e) At the above condition, the power consumption by the pump shall not exceed the recommended prime mover rating in the specified operating head range (*see* **9.7.1**). Correction shall be made for losses between the driving element and the pump as follows:

Power delivered to the pump shaft when directly connected shall be the power output of the driving element. When not directly connected, correction shall be made for the losses between the driving element and the pump. In the case of flat belt and V-belt drives, the allowances for belt losses may be taken as 6 and 3 percent respectively.

10 TEST PROCEDURE FOR CENTRIFUGAL SELF PRIMING PUMPS (IS 8418)

10.1 Performance Test

The testing of the pump performance shall be in accordance with **5**, **6**, **7** and **8**.

10.2 Self-Priming Test

10.2.1 *Test Set Up*

The self-priming pumps shall be tested to determine the priming time. The pump shall be tested at a static suction lift of 3 m (distance between the centre line of the eye of the impeller and the liquid level). No check or foot valve shall be installed in the suction piping. The test set up shall be as shown in Fig. 10.

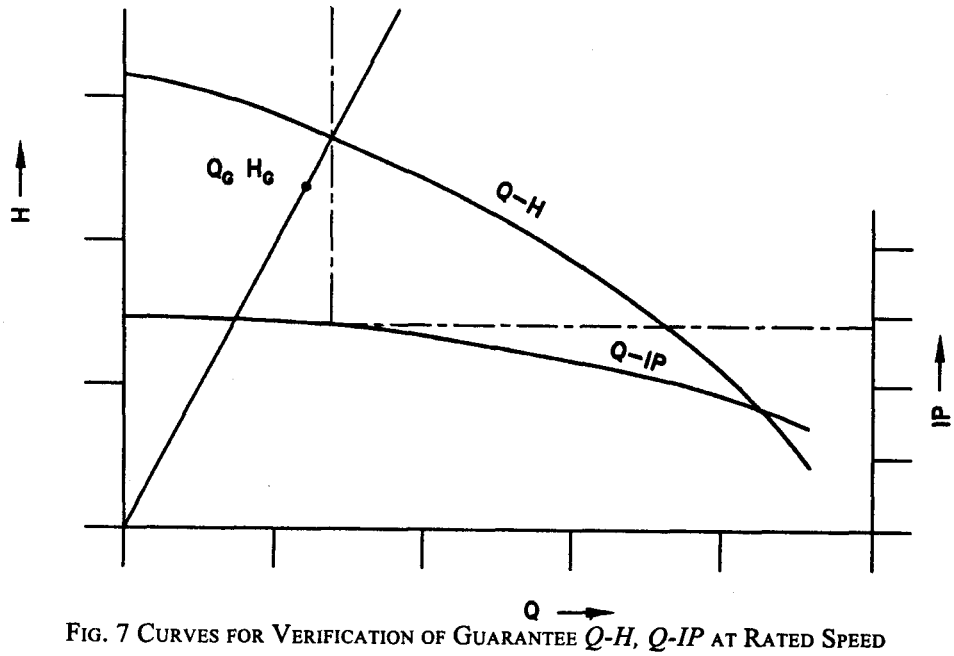


FIG. 7 CURVES FOR VERIFICATION OF GUARANTEE *Q-H*, *Q-IP* AT RATED SPEED

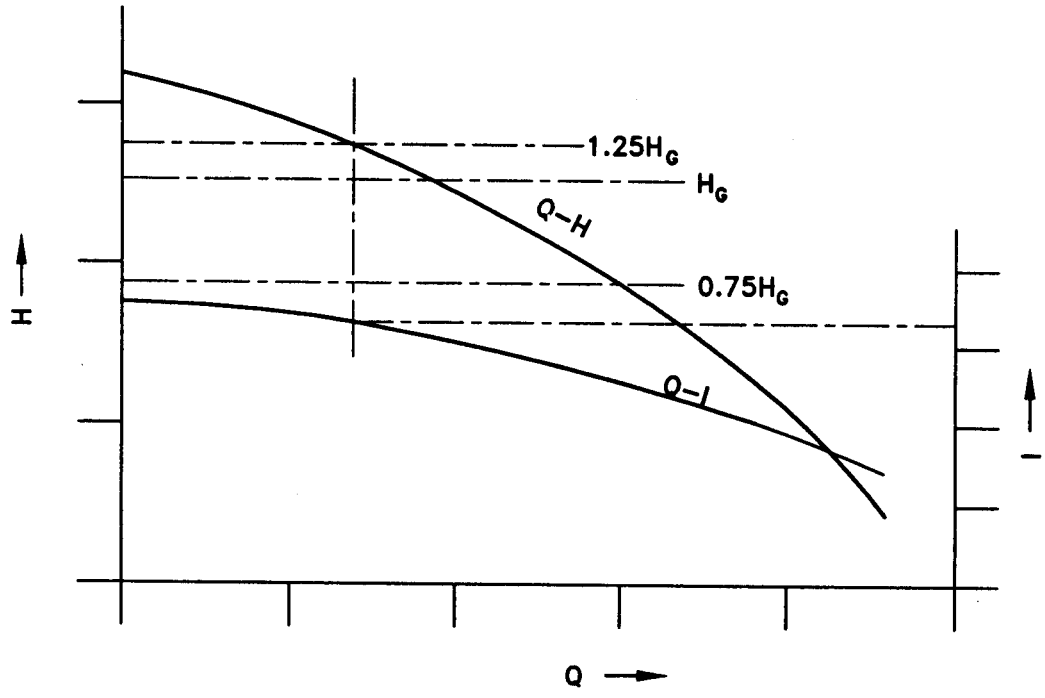


FIG. 8 CURVES FOR VERIFICATION OF GUARANTEE *Q-H, Q-I* OBSERVED TEST READING

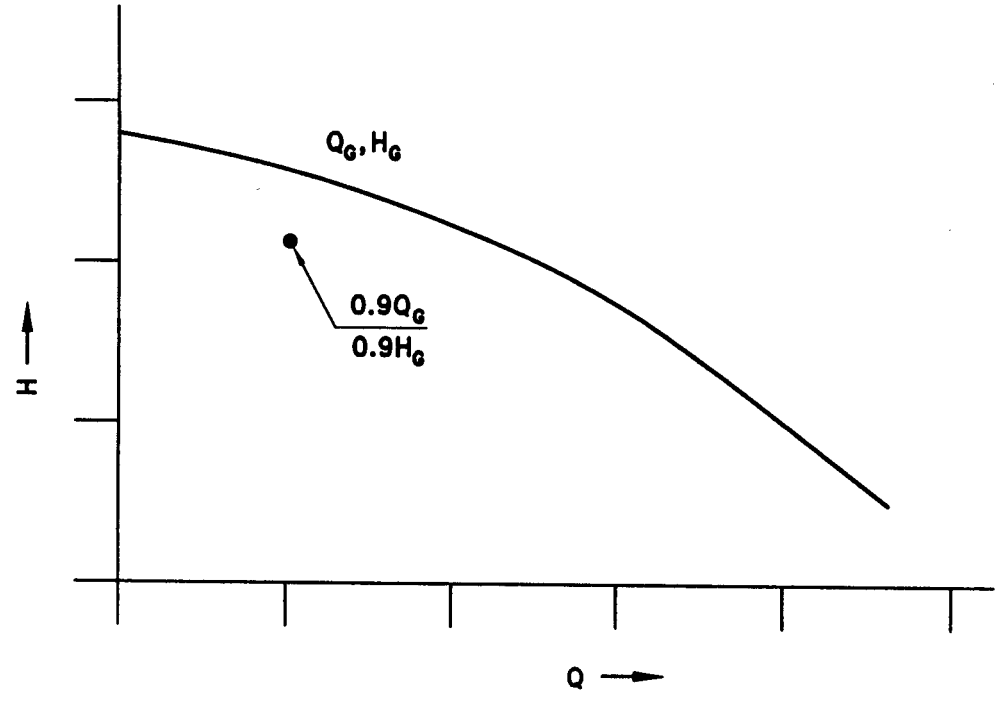


FIG. 9 CURVES FOR VERIFICATION OF GUARANTEE *Q-H* AT RATED SPEED WHERE THE CURVE IS BELOW Q_G, H_G

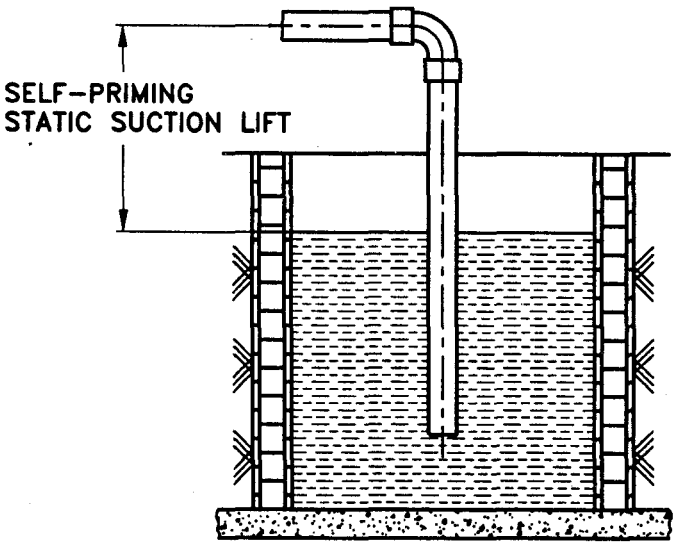


FIG. 10 TEST SET-UP FOR SELF-PRIMING TEST

10.2.2 *Test Procedure*

Fill priming chamber with water and start the pump. The priming time shall be the total elapsed time between starting the unit and the time required to obtain a steady delivery gauge reading or full flow through the discharge pipe.

10.2.3 *Priming Conversion Factor*

If a pump is connected to a larger pipe than the nominal pipe size of the pump on the suction side, it is necessary to compute the performance for the nominal pipe size of the pump. For ease of reference, the conversion factors are given in Table 3 of IS 8418. The method of finding the conversion factor is as explained below:

a) Select the size of the suction pipe actually used in the test.
b) Follow this line horizontally right to the vertical column under the heading size of nominal pipe.
c) The figure shown at the intersection is the conversion factor.
d) Divide the test time (in second) by this factor and then divide the resultant by the total length of suction pipe above water level in metre. This gives the average time in second for air removed from a suction line of nominal size per metre of length.

10.3 Guarantee of Performance

10.3.1 The pumps shall be guaranteed for their performance of the volume rate of flow and the head at the guaranteed duty point only.

10.3.2 The guarantee shall be deemed to have been met with, if:

a) The measured values of head, volume rate of flow and efficiency are within the limits indicated in **8**.
b) Power consumption by the pump does not exceed the recommended prime-mover rating in the specified head range.

11 TEST PROCEDURE AND PERFORMANCE CHARACTERISTICS OF CENTRIFUGAL JET PUMPS (IS 12225)

11.1 Factor Affecting Performance

11.1.1 *Submergence*

The submergence of centrifugal jet pump (assembly) below water level affects the overall performance of the centrifugal jet pump. All the capacities shall be given for the pump offset from well of 1.5 m for horizontal jet and the submergence of jet pump (assembly) shall be specified by the manufacturer along with minimum operating pressure. The method of obtaining higher submergence by supplying the input water to the jet pump (assembly) foot valve through pressure tank shall be as given in Annex B and Fig. 5 of IS 12225. Submergence is the level of water above the nozzle of the jet unit.

11.2 Performance Curves

The tabulated readings shall be drawn as a set of performance curves:

a) Discharge *versus* total head,
b) Discharge *versus* depth to low water level for centrifugal jet pump,

c) Discharge *versus* power input,
d) Discharge *versus* current, and
e) Discharge *versus* efficiency.

12 TESTING OF JET PUMPS

12.1 Method of Testing

Centrifugal jet pump shall be fitted with the jet pump (assembly) through proper sizes of pipes of required lengths with respective orifice plates. A pressure gauge shall be fitted to the delivery pipe of the jet pump (assembly) which is the suction pipe of the centrifugal pump. Another pressure gauge shall be fitted to the discharge pipe (delivery pipe) of the centrifugal pump. The motor is switched on. By throttling the discharge valve, the following readings shall be taken:

a) Total head (on the pressure gauge connected to the discharge pipe which is suction pipe of centrifugal pump),
b) Corrected ejector head on the pressure gauge connected to the suction pipe of the centrifugal pump which is the delivery pipe of the jet pump (assembly),
c) Discharge,
d) Power input,
e) Speed of the motor,
f) Voltage, and
g) Current.

At least three test points, at duty point, maximum head shall be taken. The manufacturer shall give the maximum jet setting depth (ejector head + 6 m) for the various types of pumps offered at which the maximum ejector efficiency is obtained. All the heads, discharge and power shall be corrected to the rated speed.

12.2 Testing Method for Centrifugal Jet Pump for Including Pipe Friction by the Use of Orifice Plate

The depth to low water level, total head discharge and power input shall be declared by the manufacturer at the duty point and the testing shall be carried out only for the duty point declared by the manufacturer.

Orifice plates as in Fig. 11 with diameters calculated in accordance with the procedure given in Annex C of IS 12225, shall be used in the pressure pipe and the delivery pipe (suction pipe of centrifugal pump) of

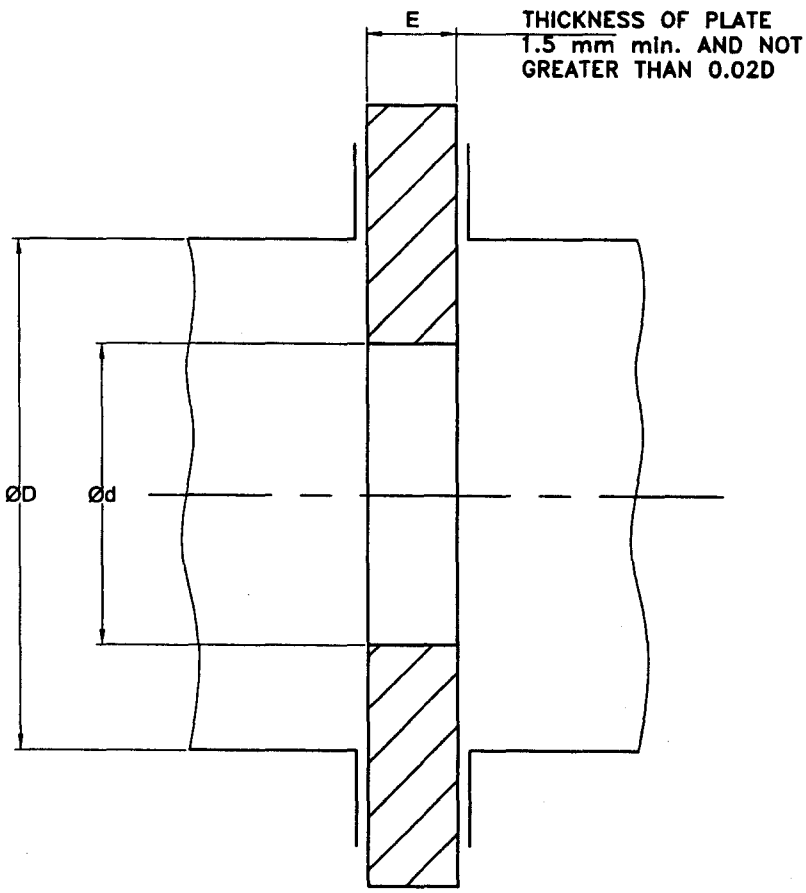


FIG. 11 SYMMETRICAL ORIFICE PLATE

the centrifugal jet pump to take into account, the field friction. Examples are given in Annex C of IS 12225 with Fig. 8, 10, 12 and 13 which give the schematic and test set up diagrams for twin, packer and duplex type centrifugal jet pumps. However, these diagrams are reproduced as Fig. 12, 13, 14 and 15 in this standard for test set up.

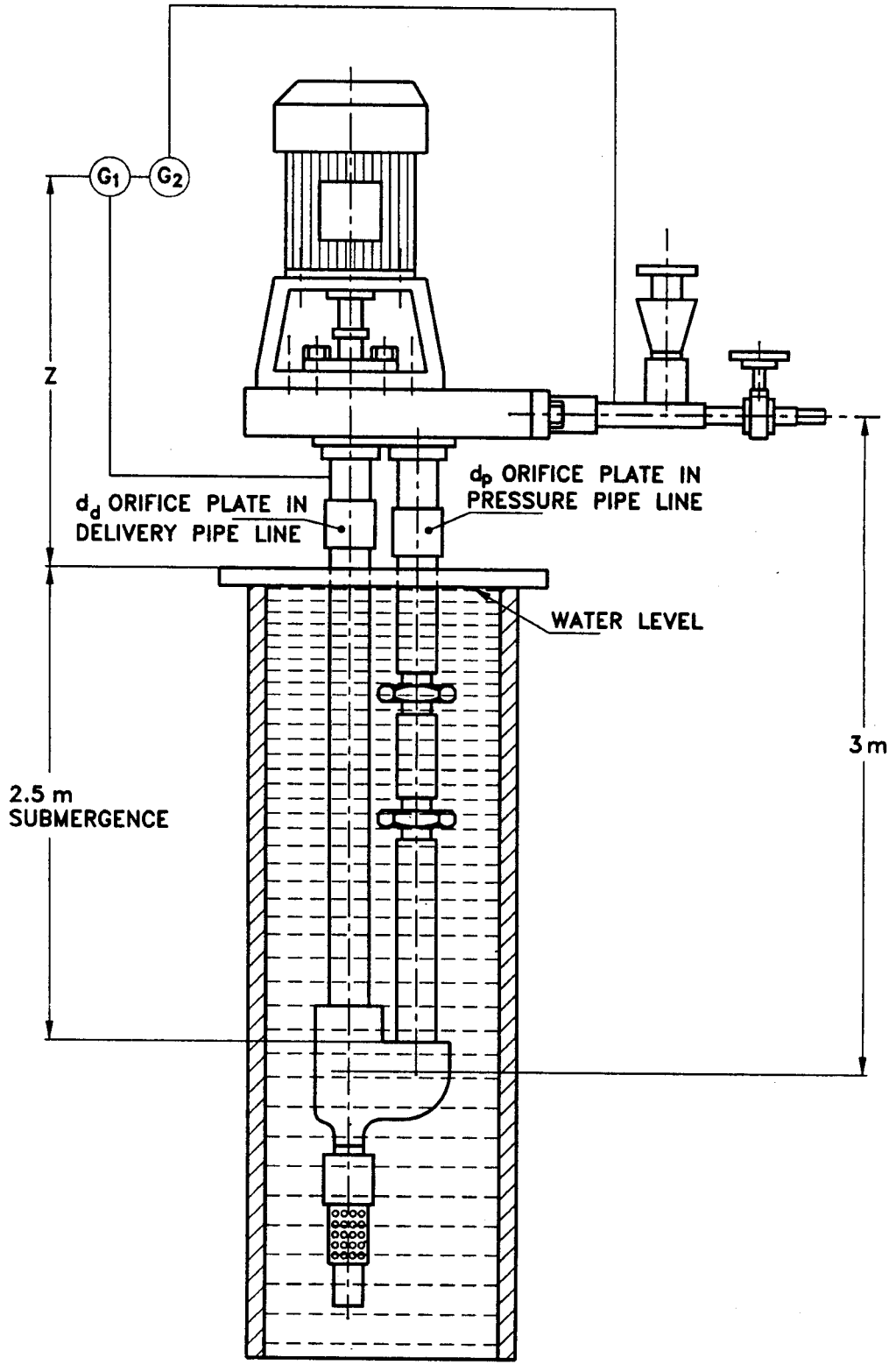
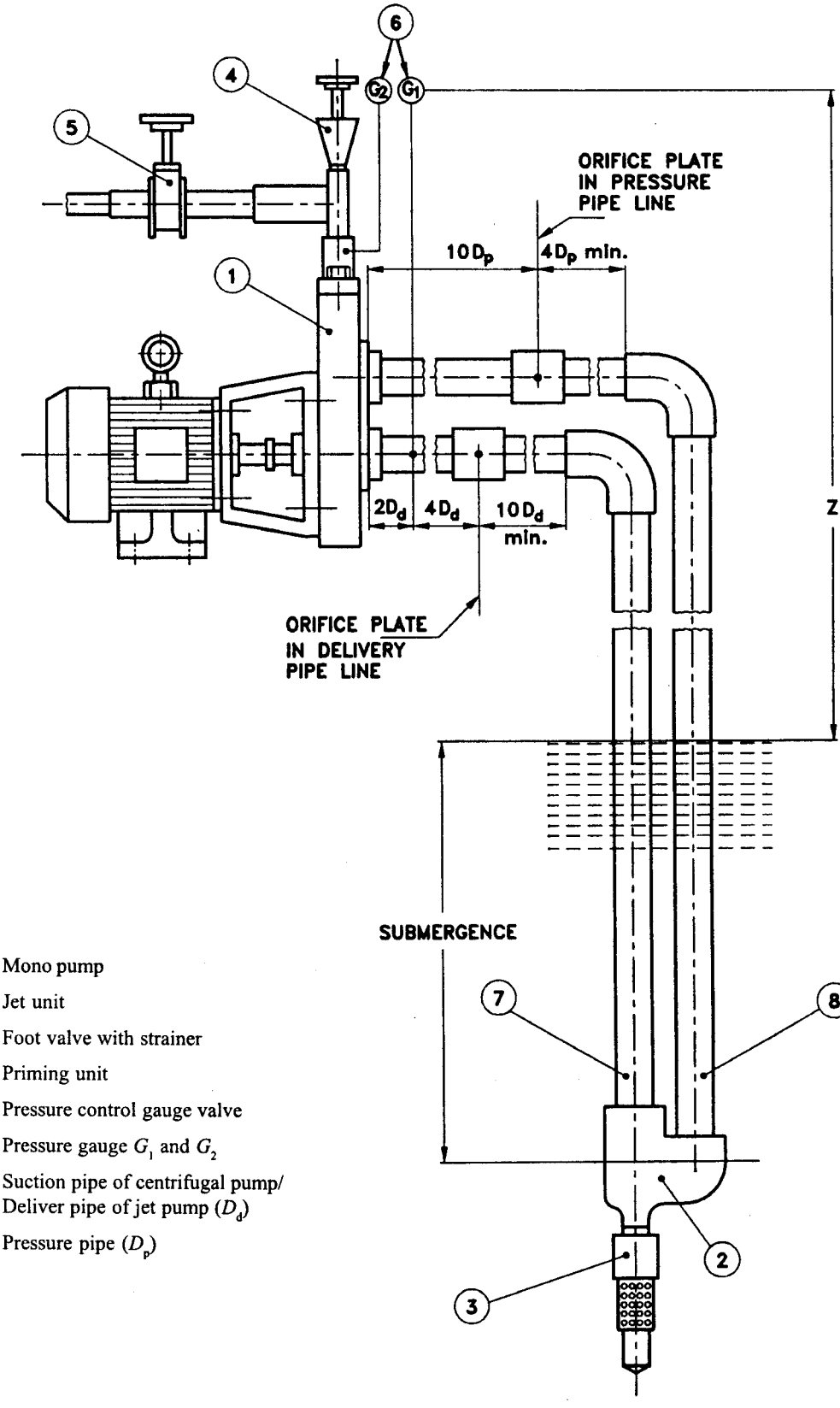


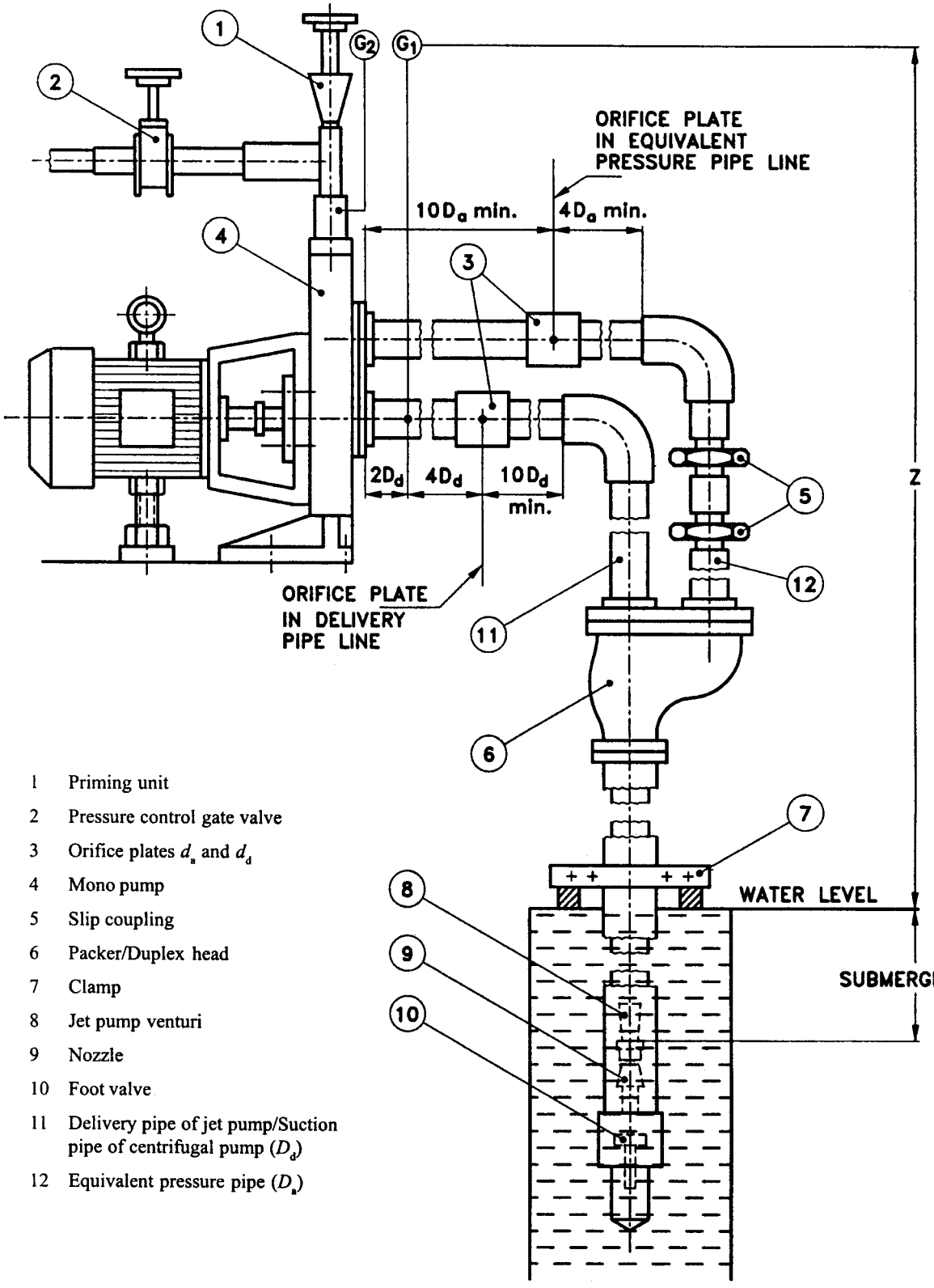
FIG. 12 TESTING INSTALLATION DIAGRAM FOR TWIN TYPE CENTRIFUGAL JET PUMP



1 Mono pump
2 Jet unit
3 Foot valve with strainer
4 Priming unit
5 Pressure control gauge valve
5 Pressure gauge G_1 and G_2
7 Suction pipe of centrifugal pump/ Deliver pipe of jet pump (D_d)
8 Pressure pipe (D_p)

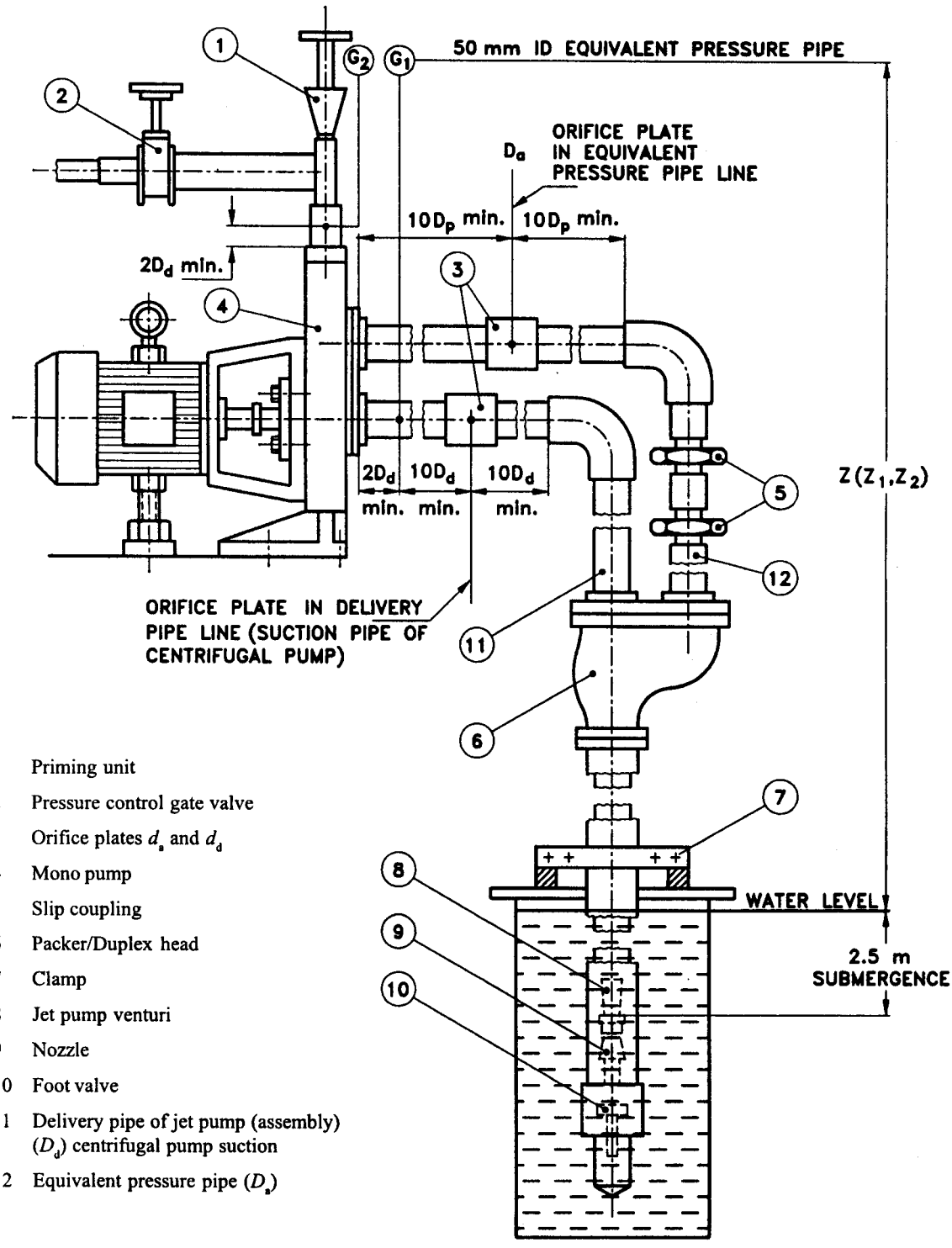
NOTE — The orifice plate shall be installed at a minimum distance of 10*D* from bend on the upstream side and pressure gauge shall be installed at minimum of 4*D* on the downstream side of orifice plate.

FIG. 13 TESTING INSTALLATION FOR HORIZONTAL TWIN TYPE CENTRIFUGAL JET PUMP



1 Priming unit
2 Pressure control gate valve
3 Orifice plates d_a and d_d
4 Mono pump
5 Slip coupling
6 Packer/Duplex head
7 Clamp
8 Jet pump venturi
9 Nozzle
10 Foot valve
11 Delivery pipe of jet pump/Suction pipe of centrifugal pump (D_d)
12 Equivalent pressure pipe (D_a)

FIG. 14 TESTING INSTALLATION FOR PACKER/DUPLEX TYPE CENTRIFUGAL JET PUMP



1 Priming unit
2 Pressure control gate valve
3 Orifice plates d_s and d_d
4 Mono pump
5 Slip coupling
6 Packer/Duplex head
7 Clamp
8 Jet pump venturi
9 Nozzle
10 Foot valve
11 Delivery pipe of jet pump (assembly) (D_d) centrifugal pump suction
12 Equivalent pressure pipe (D_s)

FIG. 15 TESTING INSTALLATION FOR PACKER/DUPLEX TYPE CENTRIFUGAL JET PUMP

The diameters to be taken for calculation of inner diameters of orifice plates as given in IS 12225 is reproduced below for ready reference:

Nominal Pipe Size	*Pipe Inner Diameter for Calculation of Orifice Plates*
mm	mm
20	22
25	27
32	36
40	42
50	53
65	69
80	81
100	106

13 TOLERANCES FOR JET PUMPS

At rated speed, the pump shall give a minimum of 92 percent of the rated depth to low water level and minimum of 92 percent of the rated total head at a minimum of 92 percent rated discharge. The pump shall not take more than 110 percent of the declared power input in the range between 92 percent of rated discharge to rated discharge. The maximum current in the operating range of depth to low water level shall not exceed the 107 percent values specified in IS 996 or IS 7538 as the case may be in order to avoid overloading the prime mover. For 2 pole single-phase motor, the value of maximum full load current shall be declared by the manufacturer. To check the declared values refer Annex D of IS 12225.

ANNEX A

(*Clause* 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	*Title*
996 : 1979	Single-phase small ac and universal electric motors (*second revision*)
1239 (Part 1) : 1990	Mild steel tubes, tubulars and other wrought steel fittings: Part 1 Mild steel tubes (*fifth revision*)
2102 (Part 1) : 1993	General tolerances : Tolerances for linear and angular dimensions without individual tolerance indications (*third revision*)
(Part 2) : 1993	Geometrical tolerances for fastners without individual tolerance indications
2952 (Part 1) : 1964	Recommendation for methods of measurement of fluid flow by means of orifice plates and nozzles: Part 1 Incompressible fluids
4984 : 1995	Specification for high density polyethylene pipes for potable water supplies (*fourth revision*)
6595 (Part 1) : 2002	Horizontal centrifugal pumps for clear, cold water — Specification: Part 1 Agricultural and rural water supply purposes (*third revision*)
7538 : 1996	Three-phase squirrel cage induction motors for centrifugal pumps for agricultural application — Specification (*first revision*)
8034 : 2002	Submersible pumpsets — Specification (*second revision*)
8418 : 1999	Pumps — Centrifugal self-priming — Specification (*first revision*)
8472 : 1998	Centrifugal regenerative pump for clear, cold water — Specification (*first revision*)
9079 : 2002	Electric monoset pumps for clear, cold water for agricultural and water supply purposes — Specification (*second revision*)
9108 : 1979	Liquid flow measurement in open channels using thin plate weirs
11501 : 1986	Engine monoset pumps for clear, cold, water for agricultural purposes — Specification (*first revision*)
12225 : 1997	Centrifugal jet pump — Specification (*first revision*)
12231 : 1987	Specification for unplasticized PVC pipes for use in suction and delivery lines of agricultural pump sets
14220 : 1994	Openwell submersible pumpsets — Specification

ANNEX B

(*Clauses* 5.1.5 *and* 5.1.6)

COMPUTATION OF MANOMETRIC SUCTION LIFT

B-1 EXAMPLES

a) Computation of manometric suction lift for testing as per **5.1.2** when total head is 10 m and above.

Specified duty parameters :
Discharge rate : 16 l/s
Speed : 1 450 rpm
Barometric pressure observed at test place : 9.8 mWC
Water temperature : 25°C
Manometric suction lift as per Table 2 : 6.0 m
Corrected manometric suction lift for altitude and temperature : 6 – 0.53 + 0.19 = 5.66 m

As per **5.1.1** six set of readings shall be taken maintaining manometric suction lift at 5.66 m.

b) Computation of manometric suction lift for testing as per **5.1.2** when total head is below 10 m.

Specified duty parameters :
Discharge rate : 17 l/s
Total head : 9 m
Speed : 1 450 rpm
Barometric pressure at test place : 9.8 mWC
Water temperature : 25°C
Manometric suction lift as per Table 2 : 6.0 m

1) Corrected manometric suction lift for altitude and temperature : 6 – 0.53 + 0.19 = 5.66 m
2) Duty point head, $H - 4$ m : 9 – 4 = 5 m
After correction, 5 – 0.53 + 0.19 = 4.66 m

As per **5.1.1** six set of readings shall be taken maintaining manometric suction lift at 5.66 m or 4.66 m whichever is lower.

ANNEX C

(*Clause* 6)

SPECIMEN SHEET FOR IS 6595 (PART 1)

PUMP TEST RECORD SHEET

Sheet No. .....
Refer Graph No.....

Nature of test – Performance test as per IS 6595(Part 1)

Pump type ....Pump Sl No.....
Suction ..... mm Delivery.....mm
Material of impeller.....

Motor make..... Motor rating.....kW Motor Sl No.....
Voltage..... Full load current, Amps.....
Meter constant: A× .....kW× .....Full load rev/min.....

Suction lift measured by: Hg manometer/Vacuum gauge
Delivery head measured by: Hg manometer/Pressure gauge

Capacity measured by – Vee-notch/Volumetric tank/Flowmeter
Class of accuracy of measuring instrument — One

Sl No.	Speed of pump, rev/min	Suction gauge reading, m	Delivery gauge reading, m	Gauge distance, Z, m	Velocity head correction, m	Total head, m	Head over notch, mm (in case of Vee-notch)	Volume (l)/time(s) (in case of volumetric tank)	Discharge, l/s	Current, A	Wattmeter reading		Motor input (*IP*), kW	Pump input (*BP*), kW	Pump output (*LP*), kW	Overall efficiency, %	Performance converted at rated speed.....		
											W_1	W_2					*H* m	*Q* l/s	*BP*, kW

Pump certified for:
i) Total Head in m.....
ii) Discharge in l/s.....rev/min.....
iii) Pump efficiency percent.....Pump input, kW .....
iv) Head range in m.....
v) *H*..... *Q*.....Guarantee factor.....
Pump efficiency at duty point, percent .....

General requirements – Satisfactory/Unsatisfactory

Date.....Tested by .....
Remarks.....
.....
.....
.....
Impeller diameter..... mm

ANNEX D

(*Clause* 6)

SPECIMEN SHEET FOR IS 8034

PUMP TEST RECORD SHEET

Sheet No. .....
Refer Graph No.....

Nature of test – Performance test as per IS 8034

Pump type ....Pump Sl No.....
Suction ..... mm Delivery.....mm
Material of impeller.....

Motor rating.....kW/HP Motor Sl No.....
Voltage..... Full load current, Amps.....
Meter constant: A×.....kW×.....Rated frequency.....

Suction lift measured by: Hg manometer/Vacuum gauge
Delivery head measured by: Hg manometer/Pressure gauge

Capacity measured by – Vee-notch/Volumetric tank/Flowmeter
Class of accuracy of measuring instrument — One

Sl No.	Frequency, Hz	Delivery gauge reading, m	Gauge distance, Z, m	Velocity head correction, m	Total head, m	Head over notch, mm (in case of Vee-notch)	Volume (l)/time(s) (in case of volumetric tank)	Discharge, l/s	Current, A	Wattmeter Reading		Motor input (*IP*), kW	Pump output (*LP*), kW	Overall efficiency, %	Performance converted at rated frequency.....		
										W_1	W_2				*H* m	*Q* l/s	*IP*, kW

Pump certified for: i) Total Head in m .....
ii) Discharge in l/s.....Frequency.....
iii) Overall efficiency percent.....Motor input, kW .....
iv) Head range in m.....
H..... *Q*.....Guarantee factor .....
Overall efficiency at duty point, percent.....

General requirements – Satisfactory/Unsatisfactory

Date.....Tested by.....
Remarks .....
.....
.....
.....
Impeller diameter .....mm

ANNEX E

(*Clause* 6)

SPECIMEN SHEET FOR IS 9079

PUMP TEST RECORD SHEET

Sheet No. .....
Refer Graph No.....

Nature of test – Performance test as per IS 9079

Pump type ....Pump Sl No.....
Suction ..... mm Delivery.....mm
Material of impeller.....

Motor rating.....kW/HP
Voltage..... Full load current, Amps.....
Meter constant: A×.....kW×.....Rated frequency.....

Suction lift measured by: Hg manometer/Vacuum gauge
Delivery head measured by: Hg manometer/Pressure gauge

Capacity measured by – Vee-notch/Volumetric tank/Flowmeter
Class of accuracy of measuring instrument — One

Sl No.	Frequency, Hz	Suction gauge reading, m	Delivery gauge reading, m	Gauge distance *Z*, m	Velocity head correction, m	Total head, m	Head over notch, mm (in case of Vee-notch)	Volume (l)/time(s) (in case of volumetric tank)	Discharge, l/s	Current, A	Wattmeter Reading		Motor input (*IP*), kW	Pump output (*LP*), kW	Overall efficiency, %	Performance converted at rated frequency.....		
											W_1	W_2				*H* m	*Q* l/s	*IP*, kW

Pump certified for:
i) Total Head in m .....
ii) Discharge in l/s.....Frequency.....
iii) Overall efficiency percent.....Motor input, kW .....
iv) Head range in m.....
H..... *Q*.....Guarantee factor .....
Overall efficiency at duty point, percent.....

General requirements – Satisfactory/Unsatisfactory

Date.....Tested by .....
Remarks.....
.....
.....
.....
Impeller diameter..... mm

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

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IS 11346 : 2002 TESTS FOR AGRICULTURAL AND WATER SUPPLY PUMPS — CODE OF ACCEPTANCE

(First Revision)

(*Page* 4, *Fig.* 2) — Substitute '4D min.' *for* '6D min.'

(*Page* 6, *clause* **5.1.7**) — Insert the following new clause after **5.1.7**:

'**5.1.8** The performance testing of Horizontal Centrifugal Pumps as per IS 6595 (Part 1) at a speed of ±20 percent of declared speed is permissible.'

[*Page* 10, *clause* **8.3**(a)] — Substitute 'IS 6595 (Part 1)' *for* 'IS 1595 (Part 1)'.

(*Pages* 10 *and* 11, *Fig.* 5 *and Fig.* 6) — Substitute 'SUCTION LIFT' *for* 'SELF-PRIMING STATIC SUCTION LIFT'.

(*Page* 11, *clause* **9.7.1**, *first line*) — Substitute 'rated frequency' *for* 'rated speed'.

[*Page* 11, *clause* **9.8**(a), *second line*] — Substitute 'frequency' *for* 'speed'.

(*Page* 15, *clause* **12.1**, *last line*) — Substitute 'frequency' *for* 'speed'.

(*Page* 20, *clause* **13**, *first line*) — Substitute 'frequency' *for* 'speed'.

(MED 20)

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